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An English translation of Dr. Dohrn's pamphlet could not fail to be serviceable to the large number of students who take an interest in the genealogical problems of morphology. — G. T. BETTANY, in *Nature*.

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## A COSMOPOLITAN BUTTERFLY. II. ITS HISTORY.

BY SAMUEL H. SCUDDER.

NOTWITHSTANDING the ubiquity and general abundance of *Vanessa cardui*, its natural history is imperfectly known. Of its life in the tropics there is no published statement beyond the brief account given by the indefatigable Horsfield; he simply mentions that in Java the caterpillar feeds on a species of *Artemisia*, the native name of which is *Godomollo*, and that the butterfly appears in December. Just beyond the tropics, at the Cape of Good Hope, Trimen reports it as found in the imago state throughout the year, but most abundant from September to March. At about an equal distance north of the tropics, on the same continent, in Egypt, this butterfly flies through the winter, and from November to March caterpillars in almost every stage may be found upon a species of *Malva*, called by the Arabs *Mlu-kheh*, while the thistles growing abundantly by the railway lines are untouched. These fragments comprise the account of this butterfly outside of Europe and North America, and the following remarks are confined to this insect as it exists in north temperate regions.

In New England this butterfly is double-brooded and hibernates in the imago state.<sup>1</sup> The hibernating butterflies do not usually begin to emerge from their winter quarters until the middle of May, and badly worn specimens continue to fly until after the middle of June. They lay their eggs during the latter half of May and early in June; these hatch in from six to eight days, and the caterpillars therefrom become fully grown between the middle of June and the middle of July; the chrysalids hang from eight to fourteen days, and disclose the first fresh butterflies about the 10th of July. These usually become abundant by the middle of the month, and at the end of the third week innumerable; they continue to emerge from the chrysalis until the early days of August, and fly until the next brood appear; these lay their eggs during the last of July and first of August, and the caterpillars

<sup>1</sup> At least so far as is known. In Europe, according to some writers, it often passes the winter in the chrysalis state; but authorities do not agree upon this point.

undergo their final transformations in the latter half of August and early in September, the autumn brood of butterflies first appearing late in August and continuing on the wing until the end of October, when they hibernate.

This account does not correspond with the history of the same insect in Europe. Meyer-Dür states that in Switzerland the butterfly may be seen on the wing from April to the end of June (wintered specimens), and from the middle of August until late in October; that is, it is single-brooded. Many authors speak of it as double-brooded, without mentioning the specific times at which it may be found; while others give the same seasons as Meyer-Dür and call it double-brooded, mistaking the double apparition of the same brood (winter intervening) for distinct broods. My own observations in the neighborhood of Geneva and Paris lead also to the conclusion that the insect is single-brooded; and no entomologist, to my recollection, has given the best proof of digoneutism, namely, two distinctly separated dates for the apparition of the caterpillar. Nevertheless, from the time of Ochsenheimer, who repeatedly says, "Ich habe zwei Generationen bemerkt," different authors have claimed for this insect a double brood; and until direct observation shall have determined the point, it should be considered, at least for some parts of Europe, an open question. In Switzerland and in England all observers seem to agree that it is single-brooded; and this is in direct contrast to the digoneutism of the same insect in New England.

If this were a solitary fact, it would possess comparatively little interest. But if we compare the annual histories of the dozen or two butterflies either actually occurring both in Europe and in Eastern North America, or represented on either continent by intimately allied forms,—if we compare their histories, we shall find several other species which present similar peculiarities, and be led to believe that the case of *V. cardui* is only one illustration of a somewhat general law.

The European *Aglais urticae*, for example, is generally double-brooded; occasionally a triple brood is mentioned; it is one of the commonest of European butterflies, and reaches from the North Cape to the Mediterranean; our congeneric *A. Milberti* is rarely found south of the northernmost parts of the United States, and yet is triple-brooded in all parts of Canada. *Everes Amyntas*, again, occurs throughout Europe, with the exception of certain northern and northwestern portions, and is double-

brooded; our *E. Comyntas*, named for the resemblance to its European congener, and by some careless authors considered identical with it, is also a wide-spread insect; but even in New England, which is toward the northern limit of its range, it is triple-brooded. The wide-spread European blues, *Argus* and *Aegon*, are usually placed among monogoneutic insects, and the latter certainly has but a single brood in England (where it is the only one of the two found); Meyer-Dür is in fact almost the only author who claims these species as digoneutic; both of them occur in Southern Europe; the American *Scudderii*, closely allied to these and an insect hardly known south of the Canadian border, is double-brooded. Our *Pontia Protodice* is triple-brooded, and the European *P. Daplidice* only double-brooded, while our common species of *Eurymus*, *E. Philodice* and *E. Eurytheme*, are triple-brooded in the north (perhaps polygoneutic farther south), and the closely allied European species only single or double brooded.

But the most striking example of all will be found in the species of the genus *Iphiclides*. The European *I. Podalirius* is confined to the Mediterranean region, while our *I. Ajax* belongs to the southern half of the United States; the regions are therefore fairly comparable; yet we can find no mention of more than two broods of *I. Podalirius*, while Mr. Edwards has shown that, even as far north as the Appalachian valleys of West Virginia, *I. Ajax* has four and sometimes five generations during the year; moreover, the first of these generations is dimorphic, and the dimorphism has in it the semblance of a seasonal character, the earlier individuals being of one type and the later of another.

These cases might perhaps be multiplied, but further positive evidence is not at hand; it should be remarked, however, that there is no reversal of this rule; among all the butterflies properly comparable on the two continents, there is no single instance where the European butterfly has more broods than the American.

This result of a comparison of the annual histories of similar European and American butterflies furnishes but another instance of that intensity which seems to characterize all life in America. The expenditure of nervous and vital energy, against which physicians vainly inveigh, which superannuates our merchants, lawyers, clergymen, and other professional men, is not induced by the simple passion for gain, place, power, or knowledge, but by an uncontrollable restlessness, a constant dissatisfaction with

present attainments, which marks us as a hurrying, energetic, enterprising people. My own experience has been that studies of precisely the same nature and undertaken under similar external conditions are accompanied by a very different mental state on the two continents. In Europe we are content to plod industriously on, unconscious of the need of relaxation; in America we bend with nervous intensity to our work, and carry the same excitement into the relaxation which such a life inevitably demands. After a long absence in Europe, a keen observer may even be directly conscious of this quickened life.

Now to what shall we ascribe such peculiarities in animal life? Naturally we look to climatic influences, and our attention is first attracted by the well-known fact that, if we compare two places in Europe and America having the same mean annual temperature, the extremes of variation will prove much greater on this side of the Atlantic. For example, while the mean annual temperature of New York is about the same as that of Frankfort, the summer temperature of the former is that of Rome, and its winter that of St. Petersburg. Moreover, the changes from summer to winter and from winter to summer are more immediate in America, or, in other words, the summers and winters are longer (by about three weeks). Such long and hot summers are of course favorable to the multiplication of broods in butterflies whose history allows a repetition of the same cycle more than once a year; the length of the winter is of slight consequence, as long as the insects can survive it; and it can have no influence upon the number of broods, unless there be species (of which we know nothing) able to resist a cold winter only in certain stages of existence, and a multiplication of whose broods might require some pliability in this respect. Not only, too, are our summers longer and hotter, but they enjoy a marked preponderance of sunshine, as compared with European summers; and this alone would almost seem capable of producing the variation we have noticed in the number of broods.

Differences will be found in all other climatic phenomena of the two continents. "From Europe as a standard," says Blodgett,<sup>1</sup> "the American climate is singularly extreme both in temperature, humidity, quantity of rain, winds, and cloudiness or sensible humidity. The oscillations of the conditions are greater, and they vibrate through long measures above and below the average. All the irregular as well as regular changes are of this

<sup>1</sup> *Climatology of the United States*, page 221.

sort, and the European observer defines the climate as directly antagonistic to that he has left." These differences, however, as Humboldt and others long ago pointed out, have a broader bearing than the above statements alone would imply ; for they are characteristic of the eastern shores of both worlds as opposed to the western, the meteorological phenomena of the eastern United States being almost precisely paralleled by those of Northern China, where great excesses of temperature occur, with wide variability, long summers and winters, and rapid transitions.

Perhaps on these grounds we can most simply account for the difference in the number of broods in certain butterflies on the two continents ; but, if so, then it follows that we ought to anticipate similar differences between the broods of some of the species found both in Europe and in Eastern Asia ; a point of which we can assert absolutely nothing, for want of data. These grounds, however, will certainly be insufficient to account for the differences to which we have alluded in man ; for what contrast could well be greater than that existing between the national character of the Chinese and that of the Americans ! We are rather forced to believe that the causes of the distinctions between the European and the American, if these are at all due to physical agencies, must chiefly be sought elsewhere. From my slight knowledge of the climatic features of Eastern Asia, it is impossible to contrast Eastern North America with the north temperate regions of the Old World, taken as a whole ; certainly the greater frequency and intensity of electrical phenomena on our shores may have some influence.

But to return to the history of our cosmopolitan butterfly. We have traced the sequence of events in its life ; let us now look more closely at some of the habits peculiar to it in either the earlier or the later stages of its existence. The ovipositing female alights upon a plant and moves about with trembling wings, and body generally on a line with the midrib, until it finds a spot to its taste ; the wings, elevated at an angle of about forty degrees with each other, now become quiet, the tip of the abdomen is bent down upon the leaf, and the egg is instantly laid. I observed one butterfly alight many consecutive times on unopened thistle-heads, thrusting her abdomen between the spines to the very sepals, as if in act of ovipositing ; but no egg was laid until she alighted on a leaf. The same butterfly appears never to lay more than a single egg upon one leaf, although she frequently deposits eggs on different leaves of the same plant, and in one

particular instance laid them upon cut leaves lying on the ground ; in this case she laid them upon the uppermost surface, whichever way the leaf was turned ; on the plant they are always laid upon the upper surface ; and I once found an egg on a spinous hair of a thistle leaf. Several eggs may sometimes be found on the same leaf, but they will always hatch at different times, showing that they were laid on different occasions, if not by different individuals. The eggs themselves vary considerably, their vertical ribs ranging from fourteen to nineteen, and averaging fifteen and a half or sixteen in number ; judging from the examination of forty or fifty specimens, it would seem as if the average were slightly greater in America than in Europe.

The caterpillar feeds principally on *Compositæ* and especially upon the tribe of *Cynareæ*, or thistles. In our country it has been found on *Cnicus benedictus*, *Cirsium lanceolatum* (the common thistle), *C. arvense*, *Carduus nutans*, *Silybum Marianum*, *Onopordum acanthium*, and *Lappa major* (burdock), — all plants introduced from Europe ; also on *Senecio cineraria*, belonging to another tribe of *Compositæ* ; on another of the *Compositæ*, one of the sunflowers, *Helianthus* *sp.* ; on *Althæa rosea* (garden hollyhock), — again an introduced plant, and one of the *Malvaceæ* ; and it is reported (perhaps by mistake for its congener, *V. Atalanta*) to have been found on the nettle. Möschler remarks that he has received neither thistles nor nettles from Labrador, and wonders upon what the caterpillar may feed in that inhospitable region. In Europe it has been taken upon various species of *Carduus*, *Cirsium*, and *Onopordum*, and other *Cynareæ*, such as *Centaurea benedicta* and *Cynara Scolymas* ; some *Senecionidæ*, such as *Achillea millefolium* and *Gnaphalium arvense* ;<sup>1</sup> on *Echium*, one of the *Borraginaceæ*, and on *Malva rotundifolia*. It seems to prefer the *Malva* in Egypt, being found abundantly on the species cultivated by the Arabs for medicinal purposes ; and since this is cut at various times during the winter, myriads of the caterpillar are doubtless annually exterminated.

The young caterpillar makes its escape from the egg, as usual among lepidopterous larvæ, by biting a slit almost around the crown of the egg, and pushing up this improvised lid ; it does not appear to devour the egg-shell, as caterpillars usually do, but, after biting a few little holes partly through the upper surface of the leaf, makes its way to the opposite side and takes up a position, each one apart from its fellow, either between the

<sup>1</sup> Horsfield, as we have seen, raised it in Java on *Artemisia*.

midrib and curled-up rim if near the tip of the thistle leaf, or next the midrib or a lateral rib, if farther back ; here it bites away the silken film and makes a nest, covering itself with a slight open web, into which it weaves the bitten particles of the film. From this retreat it sallies forth to eat irregular patches in the parenchyma, which it often partially covers with an extension of the web.

Each caterpillar, when it has outgrown this confined abode, builds for itself a separate nest, generally near the summit of a stalk ; it spins a thin web on the surface of the leaf, near the edge, if it be a broad-leaved plant, and then draws over a portion of the leaf by means of threads, completing the covering with a silken tent ; when half grown it forsakes this and forms a more perfect nest, drawing together leaves, buds, and bitten fragments by the same process, so as to form an oval cavity, about thirty-five millimetres long vertically, and a little more than half as broad. The narrow, irregular, crisped, and rather distant leaves of the thistle, on which it is most frequently found, cannot, however, be made to cover even a single caterpillar, and the spaces are closed by a thin open web, through which the inmate can readily be seen, but which is sufficiently close to retain all the rejectamenta of the caterpillar. The nest is usually covered, at least in the upper half, with spines of the plant, evidently bitten off for the purpose ; there is an opening in the nest, near or at the summit, just large enough to allow the larva to emerge, apparently made by eating away the web. The leaves which penetrate the nest are not lined with silk, but the web is frequently stretched across the inequalities of the leaf. Within this habitation the larva rests with its head downward, like its congener, *V. Atalanta* ; but, unlike it, when its earlier stages are passed, it feeds upon the upper surface and parenchyma of the leaf, without touching the under cuticle, and when these are consumed, it crawls out to seek its fortune and weave a more commodious mansion ; when, however, it has reached its final stage, it devours the entire leaf.

When about to undergo its transformation, the caterpillar does not wander far, and frequently remains upon the plant which has nourished it. A specimen bred in confinement, but which had abundance of room, formed of partially dried leaves, connected by open, angular, irregular, silken meshes, averaging about four millimetres long, a sort of cocoon, of no definite shape, but larger than its previous nest, and which it attached to the top of the cage.



The butterfly is particularly fond of fields, gardens, highways, open ground, and waste places; it frequently alights on stone walls heated by the sun, and is greatly attracted by flowers, particularly by thistles and the other plants upon which the caterpillar feeds; here it may readily be taken; not so in other spots, for although very fearless, and even impudent, it is exceedingly wary, dashing off headlong at the slightest alarm. In Florida, Dr. Chapman once found three or four entangled in the leaves of a *Sarracenia*.

Its flight is rapid, dashing, and discontinuous, it doubles frequently and abruptly, usually to the right or left rather than up or down, although it has no predilection for a particular elevation above the ground, as some other butterflies have; in these frequent changes it makes a series of spasmodic efforts, the movements of the wings being more vigorous during the initial half of each start, or perhaps confined to that period. It loves to return to the spot from which it has been driven, or to the immediate vicinity, often circling about first, as if selecting the best spot. On a windy day its flight is not a little remarkable; it rises high in the air, then suddenly darts down until it has approached within five or ten metres of the ground, when it starts upward again to repeat the process. On a warm, sunny day, it frequently flies until within half an hour of sunset, and it may be seen laying eggs at almost any hour between ten and four.

"Its wildly timorous behavior," says Meyer-Dür, "is quite striking; it is uncommonly audacious; swift and savage, it dashes irregularly about; scarcely observing the pursuer, heedless of the net, it returns directly to the place it has left, and sits with horizontally opened wings on the dry earth or spots of sand. It is a nimble, lively, youthful, untamed, petulant insect, which shows in its behavior no resemblance to its proud but circum-spect neighbor, *Atalanta*."

On alighting, it partially or wholly expands the wings; when fully spread, they are brought well forward, and are often even slightly depressed; the straight antennæ are then spread at an angle of ninety degrees and lie in the plane of the body, or perhaps slightly elevated.

Although its habit is to alight frequently, its flight is strong and well sustained. Trimen relates that a specimen flew on board a vessel in which he was sailing, when about ninety miles from Teneriffe. Reference has already been made to one of these butterflies visiting a vessel six hundred miles from the main land dur-

ing a cyclone, and other similar though not so striking instances might be added. Several accounts have also been given of the migration or simultaneous movement of this insect in swarms. Dr. Hagen records two instances ;<sup>1</sup> on October 26, 1827, Prevost saw such a moving swarm, composed of a stream of butterflies from ten to fifteen feet broad, passing from south to north for two hours. On April 26, 1851, Ghiliani saw, near Turin, a great flight of these insects ; according to Bouquet,<sup>2</sup> the day was fine, after continued rain, and a strong breeze blew from the west ; commencing at eleven A. M., the swarm came from the south-southeast and continued with a precipitate flight for five hours towards the north-northwest.

"In England and on the continent of Europe," says Trimen,<sup>3</sup> "*cardui* sometimes appears in great abundance, and then, perhaps for several seasons, will be uncertain in appearance and restricted to particular localities. I have not heard of this irregularity of appearance being noticed in other parts of the world." This is, however, the universal testimony of observers in America, and is probably due to the action of parasites. It was one of the first phenomena that drew my especial attention to butterflies. This butterfly, indeed, is one of the best subjects of study for those who wish to investigate the causes of irregular apparition ; and only such as spend much time in the field can hope to solve the problem. A close observation of the comparative abundance of the butterfly for several consecutive years in the same locality, accompanied by an attempt to rear hundreds of the caterpillars (selecting only those which are nearly full grown, and recording the proportion of healthy and infested ones), will probably show whether the attack of parasites is a *vera causa*.

As regards the parasites, Prof. A. E. Verrill has reared from caterpillars of this insect a species of *Microgaster* called *M. fructuosus* by Cresson. Mr. Riley has also bred a dipterous parasite ; its larva usually issues from the victim while the latter is in the caterpillar state, though sometimes not until it has transformed to chrysalis ; and in one instance the *Vanessa* completed its metamorphoses with the parasitic fly yet in its abdomen ; it did not, however, properly expand its wings. Mr. Riley has also bred *Ichneumon rufiventris* Brullé from this insect ; this hymenopteron issues from the anterior extremity of the chrysalis, infested spec-

<sup>1</sup> Stett. Entom. Zeit., xxii. 80.

<sup>2</sup> Annales Soc. Ent. Fr. [2] ix. Bull., 56.

<sup>3</sup> Rhop. Afr. Austr., 121.

imens of which may always be recognized by their pale color. In Europe, the caterpillar is infested by the larvæ of a *Microgaster*; parasites reared by me perforated the skin of the caterpillar August 19th and made their cocoon on its body. September 4th the box containing the cocoons was opened, disclosing both dead and living imagines; they belonged to two distinct species, those of the smaller being dead and dry, while those of the larger were either living or recently dead; on the succeeding day the remainder of the larger ones appeared, and proved to be, as identified by my friend Mr. Drewsen, of Copenhagen, *Microgaster sub-completus* var. ? von Esenb., and the smaller an undetermined species of the same genus, probably undescribed. Of the former 3♂ and 15♀ emerged; of the latter 8♂ 3♀; besides these, four larvæ had been taken from their cocoons and preserved in that state; all of these came from the body of a single caterpillar. The larger species is probably the actual parasite of *V. cardui*; the latter, a parasite of the parasite.

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## AQUARIA: THEIR PAST, PRESENT, AND FUTURE.

BY WILLIAM ALFORD LLOYD.

**E**IGHTY-SIX years ago—in the year 1790—there might have been seen trudging along the streets of Edinburgh an “old blue-coated serving-man,” carrying an earthenware pitcher or jar, of three or four gallons’ capacity. That pitcher contained sea-water for the marine aquarium of Sir John Graham Dalyell, Bart., who thus employed a man, or probably a succession of men, from the time he began aquarium-keeping till he finished at his death in 1851, a period of sixty-one years. The jar was sent to the sea to be filled twice or thrice weekly; but averaging it at five times a fortnight, and allowing four miles for each double journey from Great King Street to the sea and back, that amounted to 39,650 miles from the year 1790 to the year 1850, which was an enormous and perfectly needless expenditure of force, expressed in time and money, even although the results of Sir John’s investigations were given to the world in five such important quarto volumes as his *Rare and Remarkable Animals of Scotland*, 1847–48; and his *Powers of the Creator* displayed in the *Creation*, 1851–58.

Dalyell’s mode of operation, as told to me by his sister Elizabeth, in two letters dated 1860, and printed in the *Zoölogist* of